

Evaluating the Application of Machine Learning to Control of Advanced Life Support Systems

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Proposal Summary

- Experimentally evaluate a specific set of machine learning techniques in the domain of Advanced Life Support Systems (ALSS)
 - learning at both control and sequencing levels
 - control parameters (e.g., pump setting)
 - contexts for actions (e.g., when to shut off machine)
 - test with hardware (WRS, BIO-Plex) and simulations
- Design an interface between these learning algorithms and NASA autonomous control architectures
 - investigate transfer between off-line and on-line learning

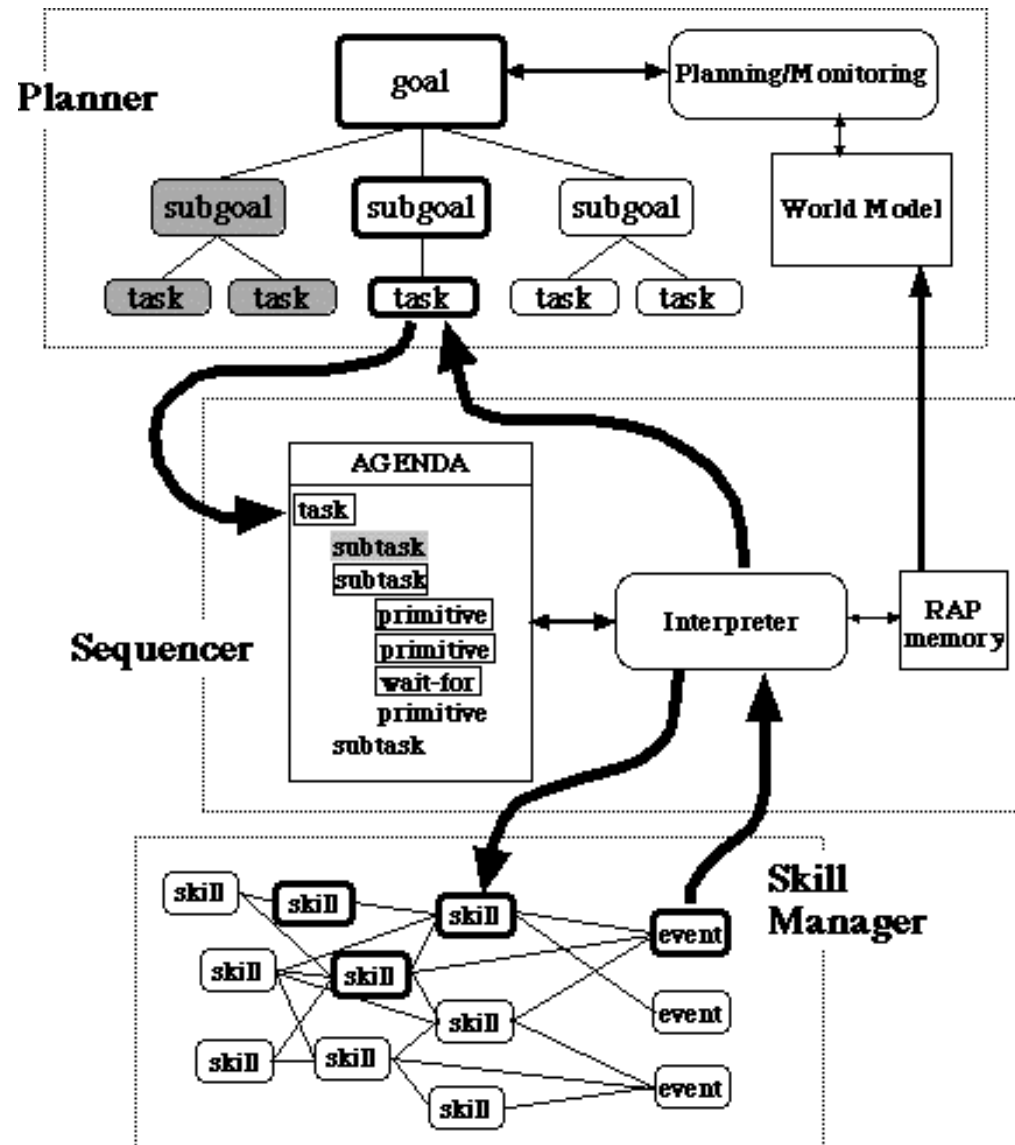
Technical Approach

- Three inter-related tasks:
 - define learning tasks
 - determine time scales
 - determine feedback
 - choose learning algorithms
 - reinforcement learning (Boyen, Subramanian)
 - genetic algorithms (Schultz)
 - EBL and CBR
 - design interface with control architectures
 - 3T
 - Remote Agent
 - Off-line and on-line learning (after Shultz et al)

Evaluation

- Task specific evaluation
 - change in efficiency of system after learning
 - maintenance of system within pre-determined bounds
- System and architecture evaluation
 - efficiency in learning
 - speed at which learning system converges to an acceptable level of performance
 - stability
 - does the system converge to a fixed set of behaviors/parameters or does it oscillate?
 - robustness
 - does the system converge to a robust state in the sense that small changes to a part of the control system do not dramatically affect the entire control system?

3T Architecture



Milestones

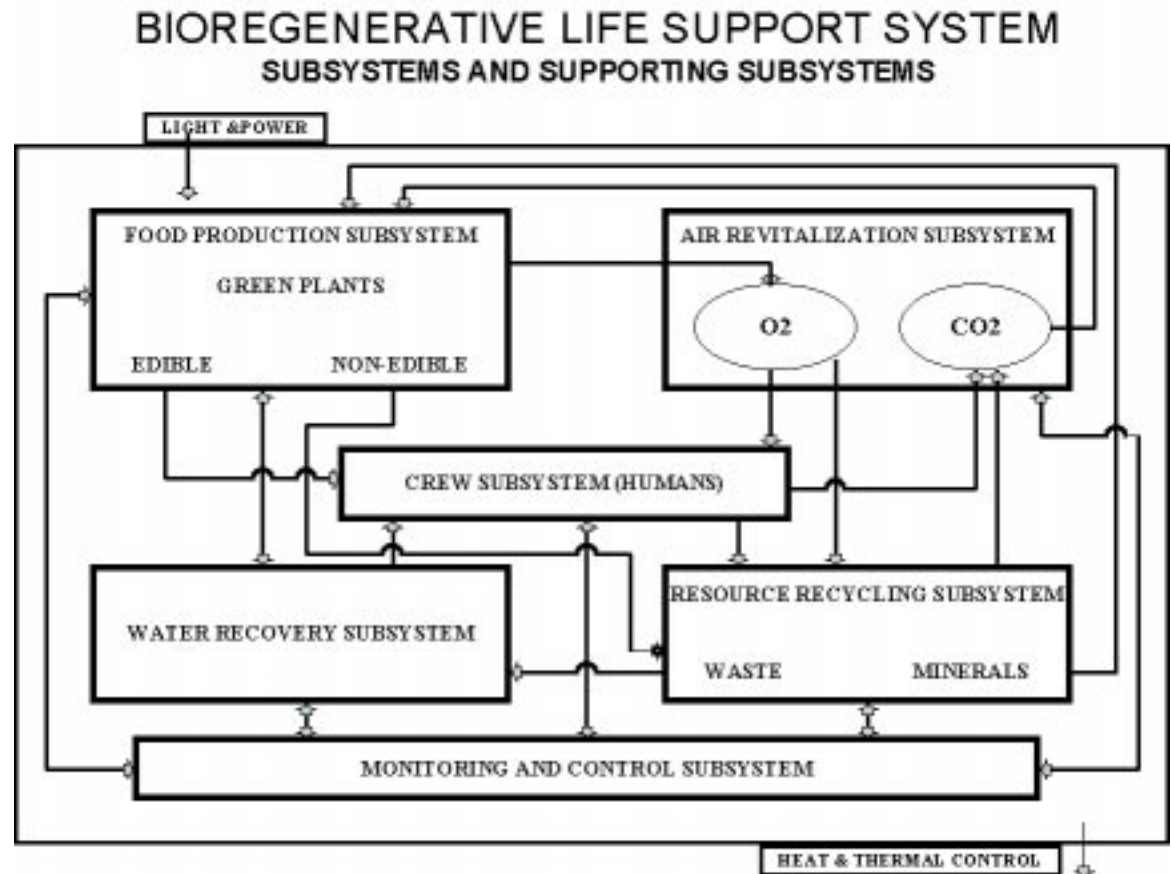
- FY 2000
 - white paper that discusses machine learning tasks and algorithms
 - paper based on experiments and prototypes using VCCR and WRS test data (3T already controlling)
- FY 2001
 - prototype and evaluate small number of machine learning algorithms in hardware and simulation
 - participate in initial testing of BIO-Plex (3T chosen)
- FY 2002
 - integration with architectures
 - plan for adaptive control of BIO-Plex

Customer Relevance



- BIO-Plex
 - 425 day test in 2006
 - crew change-out and overlap
 - letter of support from Terry Tri

- ISPP
 - unknown environments
 - optimization of propellant production



Benefits

- Decrease in pre-programming and re-programming control systems
 - less cost
 - less time
- Increase in efficiency of control systems
 - better utilization of resources
 - more robust operation
- Better scientific understanding of real-world applications of machine learning